Mercury Rotation Parameters from Inter-Year Interferometry

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The spin-orbit resonance state existing for Mercury implies that its obliquity θ is very close to 0 deg. The magnetic field observed by Mariner 10 (Ness et al., 1974) is explained most simply by a dynamo in a currently molten core. If Mercury has such a core, then Peale (1988) has shown that dissipation will carry Mercury to rotational Cassini state 1 (in which the spin vector, the orbit precession angular velocity vector, and the orbit normal vector are all coplanar). Under plausible conditions, a libration ϕ in longitude will forced with an 88 day period (Peale, 1988), and further that the size and state of Mercury's core can be deduced from measurement of θ and ϕ, along with determination of C20 and C22 of the gravity field to modest accuracy (Peale, 1997). The dynamics of Mercury's orbit, along with the Mariner 10 gravity field and associated uncertainties, imply the following ranges accord to Peale (1997):

$$1.7 \text{ arcmin} < \theta < 2.6 \text{ arcmin}$$

$$20 \text{ arcsec} < \phi < 60 \text{ arcsec}$$

Radar observations of (radar)bright features at the poles of Mercury have improved the limits on the obliquity (Harmon et al., 1994). Further improvements in the knowledge of the obliquity, and measurement of ϕ present a challenging problem in astrometry. In addition to full-disk imaging using the upgraded Arecibo telescope, a new technique appears to be possible using ground-based observations which may be able to measure θ and ϕ to the requisite accuracy. This new technique uses interferometry between observations of same subradar point on Mercury viewed in precisely the same geometry at greatly different times. The "baseline" is constructed from the two (very slightly different) positions of the observing point on Earth as viewed from Mercury. Detailed predictions will be shown for observations on Aug.17, 1998 and Aug. 01, 1999. This technique uses some of the same mathematical formulations as Zebker and Goldstein (1986), and Goldstein et al. (1988). The "fringes" will exist within ~ 200 km diameter spot surrounding the subradar point on the two dates, and the fringes will persist for ~2 hours if voltage data are obtained at the appropriate times. Other opportunities for these observations are June 2000-Sept 2003, May 2000-May 2004, July 2000-Aug 2004, July 2001-July 2004, and March 2000-Jan 2003, among others.

References: Ness et al., *Science*, **185**, 151-154, 1974; Goldstein et al., *Radio Science* **23(4)**, 713-720, 1988; Zebker and Goldstein, *JGR* ,**91(B5)**, 4993-4999, 1986; Peale, S. J. in MERCURY, 461-493, Univ. of Arizona Press, 1988; Peale, S. J. Lun. Planet. Sci. XXVII, 1081-1082, 1997; Harmon et al., *Nature*, **369**, 213-215, 1994.

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